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Formulas for Relay Intercropping and Crop Sequence Systems Evaluation.

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Abstract: The aim of this study established formulas for relay intercropping and crop sequence evaluations based on biological and economical parameters from crop intensification perspective. At the same time as prediction formulas to predict the success of intensive crop sequences from farmers view perspective. Four intensive successions and five conventional sequences were conducted in 2005/06 and 2006/07 years in Dakahlia governorate. The results supported the superiority of sequence 1 including wheat with cotton in relay intercropping. This intensive sequence registered the highest mean net returns due to higher production of both crops coupled with better market price.The formulas were established for estimating the Economic Yield Advantage Ratio (EYAR) whether intensive or conventional sequences systems. $EYAR_1$ equation values showed that the relay intercropping of cotton with wheat was superior in all successions by values ranging between 17.08 to 181.02 %. $EYAR_2$ equation values were demonstrated that the intensive sequence 2 was superior to the traditional sequence 6 by 26.46%. On the other hand, the differences between $EYAR_2$ values and net return ratio values due to the variations of area time land occupied of both sequences. So, it can be said that the net return values given were not true enough to evaluate the comparisons between the crop sequences. $EYAR_2$ equation values showed that the both of intensive sequence 3 and traditional sequence 5 were failed by -4.59 and -5.53 %,respectively, compared with conventional sequence 7. This means that the increasing in net return of sequence 3 was not enough for the compensate the increasing in the sequence duration. The economic evaluation of water requirements of each sequence displayed that the cotton /wheat in relay intercropping recorded the highest net return for m^3 of water requirements.

Key words: Traditional - yield advantage – water requirement.

INTRODUCTION

Double cropping systems of summer crops (fallow, maize. Cotton and soy bean) following winter crops (berseem, field bean and wheat) are common in Egypt. The yield and its components of winter crops were markedly affected by the preceding summer crops[1]. Maize preceded by faba bean was on top of net income. While maize preceded by wheat was less income. Alternation of a legume and maize here was merited for a higher yield (2.5 ardab /fed.) of maize grains[2]. Macro and micro-nutrients content of soil were affected by the preceding crops and consequently affected the yield and its components of the succeeding crops[3]. Faba bean preceded by cotton markedly surpassed those preceded by maize in growth yield and its components[4]. In another study, using berseem as a preceding crop gave higher profits than using faba bean. In the meantime faba bean as a preceding crop to maize gave higher profits than wheat in most instances[5].

Relay cropping is a method of multiple cropping where summer crops (soybean or cotton) are planted into standing winter crop (wheat) well before winter crop harvest (4 to 8 weeks). The word “relay” is used to describe the fact that a second crop is seeded into an existing crop before the harvest of the first crop. Therefore, the two crops are in different stages of their respective life cycles. As the winter crop (wheat) is maturing, the inter seeded summer crop (cotton or soybean) may be just beginning its reproductive growth stage. Relay intercropping of soybean [Glycine max (L.) Merr.] or cotton [Gossypium barbadence L.] into standing wheat [Triticum aestivum L.] allows for earlier planting of the summer crop than with sequential double-crop systems. The effect of the relay intercropping of cotton (Var. Giza, 85) with wheat (Var. Gemmieza 3) was studied and found that the intercropping gave advantage in land use estimation of LER which revealed an increase in efficiency of land use by 82, 93 and 213% in the first season and by 81, 96 and 211% in the second season when cotton was

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sown relay intercropping with wheat on 5, 25 of March and 15 of April[6,7].

Many factors need to be included in the cost of production estimates that all farms should be calculating as they consider length of rotation and cropping sequences. These factors include yield and loss due to increased pest damage and decreased soil health, as well as increased operating costs in response to these negative impacts. It is also important to consider the risk of development of pesticide resistance in poorly designed cropping systems[8].

MATERIALS AND METHODS

Field experiments were conducted in 2005/06 and 2006/07 years at Mansoura district,Dakahlia governorate, through Crop Intensification Res. Dep. Program. Field experiments comprised nine successions including intensive and conventional crop sequences. The winter crops were : Wheat (*Triticum aesitivum* (cv.Gemmieza 3)), faba bean (*Vicia faba* (cv. Giza 35)), Multi cut – clover (*Trifolum alexandrinum* (cv. *Meskawy*)), Mono- cut clover (*Trifolum alexandrinum* (cv. *Fahl*)). The summer crops were : Summer maize (Zea mays L. (cv. T.W.C 324)), Fodder maize (*Zea mays L.* (cv. *Balady*)) and Cotton (*Gossypium barbadence L* (Var. Giza 85)). The fall crop was: Fall maize (Zea mays L. (cv. S.C. 3062)).

The experimental site in the present work was occupied by berseem followed by maize in previous year. Management started with plowing and compacting. Super phosphate (15 % P_2O_5) fertilizer was added prior to final plowing for all experimental plots. Potassium sulphate (48 % K_2 O) and nitrogen fertilizers were added as the recommended doses for each crop.

Intensive Successions Systems: 1) cotton / wheat in relay intercropping. 2) Faba bean - Summer maize / Fall *(Nili)* maize. 3) Fodder maize- Wheat- Summer maize. 4)- Mono-cut clover - Wheat - Summer maize.

Conventional Successions Systems: 5) Multi-cut clover - Summer maize. 6)Faba bean - Summer maize. 7) Wheat - Summer maize. 8) Two-cut clover - cotton. 9) Wheat - cotton.

The nine treatments were arranged in four randomized blocks with plot size of 180 m^2. Regarding the cotton with wheat relay intercropping, wheat seeds was sown in row 15 cm apart on terraces (wide ridges 90 cm) at seeding rate of 60 kg/fed. And cotton seeds was sown fundamental to irrigation of wheat on two ridges of the terraces in hills, 25 apart with seeding rate of 30 kg/fed.While the other crop sequences, clover and wheat seeds were distributed in plots using the broadcast methods (conventional methods). Faba bean seeds were planted in hills 20 cm on double row ridges 60 cm apart. Fodder maize seeds were planted in hill on three rows on ridges 60cm apart and the distance between the hills was 20 cm. Maize was planted in single row ridges 70 cm. apart in hills spaced 30 cm.

With respect to sole cotton planting, the cotton seeds were planted in hills 25 cm apart on row ridges 60 cm. at seeding rate of 30 kg/fed. The other cultural practices were followed as the recommendations.

The agricultural year usually starts soon after harvesting the preceding autumn, which beginning of October and ended before the beginning of November in the next year. The agricultural year will consider 365 days. The duration by days of sequential were accounted from the date of the first crop planting until harvesting date of the last crop. It was called "Area time land occupied ".

Fresh yield ton/fed. of berseem and fodder maize were determined for each cut on the whole plot basis. The fresh weight was determined immediately. Seed and straw yields (Ton/fed.) of field bean,grain and straw yields (Ton/fed) of wheat as well as seed cotton yield (kg/fed.) were recorded from whole plot.

The economic evaluation used was based on the relation between inputs and outputs for different crop enterprise in the crop sequences. This was calculated from the production costs and prices published by Department of Agric. Econ., Ministry of Agric., Egypt. Data were statistically analyzed[9]. L.S.D. at 0.05 level of significance was used to compare means of different treatments by using multiple range test[10].

The aim of this study was established new formulas for relay intercropping and crop sequence evaluations based on biological and economical parameters from crop intensification perspective.At the same time as prediction formulas to predict the success of intensive crop sequences from farmers view perspective.

RESULTS AND DISCUSSION

Wheat yields were the highest (3.343 and 3.393Ton/fed in first and second years,respectively) when wheat was preceded by clover as catch crop (succession 4) and lowest yields (2.883 and 3.153 Ton/fed in first and second seasons, respectively) when preceded by Fodder maize (succession 3) (Tables 2 and 3). Same trend was recorded with summer maize crop. Grain yield was the highest when maize was grown after faba bean as winter legume crop in successions 2 and 6, where grain yields recorded 4.194 and 4.120 Ton/fed as an average of both years,

Table 1: Illustrated the chemical analysis of soil after maize in two years.

Year	pH	$CaCo_3$ %	O.M. %	T.s.s. %	Available (ppm) Macro-nut		
					N	P	K
2005-06	7.7	1.5	0.7	0.14	39	14	540
2006-07	7.8	1.4	0.9	0.14	45	16	530

Table 2: Total costs (LE/F). , Yield (Ton/F.) , Price (LE/ production unit), Duration (days) and Water requirements (m^3) of crop sequences in 2005-2006 year.

	Crop sequence	Total Costs LE/F.	Yield Ton/F.	Price LE/ Production unit	Duration days/ sequence	Water requirements m^3
1	wheat	1921	Grain 3.180	1100	334	2034
			Straw 2.775	500		
	cotton	2622	8.3 Kintars	850		3535 #
2	Faba bean	1800	Seed 1.503	1800	418	1583
			Straw 1.530	134		
	Summer maize	1838	Grain 4.137	967		3507
			Straw 3.120	127		
	Fall maize	1950	Grain 2.085	967		2872
			Straw 3.234	127		
3	Fodder maize	531	1cut 15.3	75	352	1653
	Wheat	1821	Grain 2.833	1100		2034
			Straw 2.700	500		
	Summer maize	2080	Grain 3.388	967		3507
			Straw 2.736	127		
4	Mono - cut clover	548	1 cut 13.33	140	352	1250
	Wheat	1821	Grain 3.343	1100		2034
			Straw 3.123	500		
	Summer maize	1908	Grain 3.583	967		3507
			Straw 2.881	127		
5	Multi cut clover	2576	4 cut 38.3	140	352	3407
	Summer maize	2484	Grain 4.183	967		2034
			Straw 3.240	127		
6	Faba bean	1841	Seed 1.477	1800	352	1583
			Straw 1.362	134		
	Summer maize	2484	Seed 4.020	967		3507
			Straw 2.913	127		
7	Wheat	1922	Grain 3.192	1100	299	2034
			Straw 3.096	500		
	Summer maize	2484	Grain 3.371	967		3507
			Straw 2.877	127		

Table 2: Continue

8	Two-cut clover	900	15.ton	140	388	1250
	cotton	2622	8.5 Kintars	850		3977
9	Wheat	1921	Grain 3.160	1100	334	2034
			Straw 3.100	500		
	Cotton	2622	4.30 Kintars	850		3977

cultivation irrigation of cotton (m^3) was discount from the water requirement /F.(Last irrigation of wheat the same irrigation of cotton cultivation)

Table 3: Total costs (LE/F). , Yield (Ton/F.) , Price (LE/ production unit), Duration (days) and Water requirements (m^3) of crop sequences in 2006-2007 year.

Crop sequence		Total Costs LE/F.	Yield Ton/F.	Price LE/ Production unit	Duration days/ sequence	Water requirements m^3
1	wheat	2050	Grain 3.23	1166	336	2034
			Straw 3.00	500		
	cotton	2722	8.5 Kintars	850		3535 #
2	Faba bean	1841	Seed 1.350	2166	415	1583
			Straw 1.500	134		
	Summer maize	2084	Grain 4.252	967		3507
			Straw 3.120	127		
	Fall maize	2014	Grain 1.950	967		2872
			Straw 3.84	127		
3	Fodder maize	650	1cut 16	75	350	1653
	Wheat	1900	Grain 3.153	1166		2034
			Straw 2.482	500		
	Summer maize	2200	Grain 3.400	967		3507
			Straw 3.240	127		
4	Mono - cut clover	810	1 cut 14.00	150	350	1250
	Wheat	1925	Grain 3.393	1166		2034
			Straw 3.400	500		
	Summer maize	2100	Grain 3.433	967		3507
			Straw 2.881	127		
5	Multi cut clover	2800	4 cut 40.2	150	350	3407
	Summer maize	2684	Grain 4.100	967		2034
			Straw 3.240	127		
6	Faba bean	2186	Seed 1.627	2166	350	1583
			Straw 1.512	134		
	Summer maize	2684	Seed 4.220	967		3507
			Straw 2.913	127		
7	Wheat	2075	Grain 3.222	1166	296	2034
			Straw 3.096	500		
	Summer maize	2684	Grain 3.225	967		3507
			Straw 2.877	127		

Table 3: Continue

8	Two-cut clover	1300	16.ton	150	387	1250
	cotton	2722	8.7 Kintars	850		3977
9	Wheat	2075	Grain 3.225	1166	336	2034
			Straw 2.850	500		
	Cotton	2722	4.30 kintars	850		3977

cultivation irrigation of cotton (m^3) was discount from the water requirement /F. (Last irrigation of wheat , the same irrigation of cotton cultivation)

respectively. These data were illustrated in Tables 3 and 4. Kelner *et al*[11]; Chalk,[12]; Wivstad *et al*[13]; and Maiksteniene and Arlauskien[14], reported that the abundant nitrogen –rich residues of legume crops break down gradually, especially in clay soils, therefore nutrients are released slowly. The lowest grain yields of summer maize (3.394 and 3.298 Ton/fed as an average of two years of successions 3 and 7, respectively) were obtained with wheat as a preceding winter crop. Although, grain yield of summer maize that grown after wheat (succession 4) which was preceding by Mono- cut clover recorded 3.508 Ton/fed as an average of both years. Magyla[15]; and Rasmussen *et al*[16], reported that the biological nitrogen can influence not only winter wheat yield formation throughout all stages of vegetable growth but also cultivation of cereals in longer sequence. The results showed clearly the superiority of clover as preceding crop for maize.The inclusion of clover as a catch crop (Mono-cut clover) before wheat is an procedure to increase the yield of wheat obtained in succession 4 by 12.53 % as average of both years, compared with wheat yield of succession 3. These results were parallel with the results were obtained by El-maihy,Amira[17].

Concerning relay intercropping of cotton with wheat, grain yield of wheat did not perceptible differ by sowing wheat conventional (succession 9)or on wide ridges when wheat was sowing in relay intercropping with cotton (succession 1). Regarding cotton, relay intercropping cotton with wheat showed negligible difference in cotton seed yield compared with sowing cotton sole in sequence 8 (Traditional sequence}. These results are in agreements with those found by Kamel *et al*.[18]; Hussein, Samira(a)[19]; Toaima[20] and Hussein, Samira (b)[21]. While seed cotton yield of sequence 9 was the lowest compared with sequence 8, these results could be interpreted through the fact that the growing season of cotton preceded by wheat was shorter than that preceded by berseem as a winter crop.

In table 4, the highest area time land occupied were registered with crop sequence 2. The shortest area time land occupied was recorded by the sequence included wheat as winter crop followed by summer maize crop (sequ.7).Growing cotton with wheat in relay intercropping (sequ.1) recorded 91.77% of area time land occupied, average of the two years.

The results clearly shows significant difference between the net returns produced by the different crop sequences in both years (Table 4). The results supported the superiority of sequence1 including wheat with cotton in relay intercropping.This intensive sequence registered the highest mean net returns due to higher production of both crops coupled with better market price. This net return was superior than obtained by successions 8 and 9 by 31.20 and 85.63 %, as an average of two years, respectively. The next best remunerative sequence was Mono-cut clover-wheat- summer maize (4). Faba bean – summer maize Sequence (6) recorded the lowest net return in the two years due to relatively low productivity and prices of faba bean.

Formulas were established for relay intercropping and crop sequences evaluations based on biological and economical parameters from crop intensification perspective. The formulas were established for estimating the Economical Yield Advantage Ratio (EYAR) of the relay intercropping and crop sequence systems.

1-Evaluation of relay intercropping in comparison with a sequence:

Economical Yield Advantage Ratio $_{(relay/\ sequ.)}$ ($EYAR_1$)

$$= [(\sum_{i=1}^{n} (\sum_{j=1}^{n^-} Y_{aij}\ Pr_{aij}) - \sum_{i=1}^{n} Co_{ai})\ D_b]$$

$$[(\sum_{L=1}^{m} (\sum_{K=1}^{m^-} (Y_{bLK}\ Pr_{bLK}) - Co_{bL})))\ D_a]^{-1}$$

Economical Yield Advantage Ratio as percentage = (($EYAR_1$) -1)x 100= + %

Where :

Formula numerator should be occupied by crop sequence (a) (relay intercropping crops).

Formula denominator should be occupied by crop sequence (b).

n : number of crops pertaining to crop sequence (a).

n^- : number of main and by products together of crops.

Table 4: Durations (days) , Area time land occupied % and Net return (LE/F) of relay intercropping and crop sequences of two years.

Crop sequences	Duration days	Area time land occupied. %	Duration days	Area time land occupied %	Net return LE/F .	
		2005/2006		2006/2007	2005/2006	2006/2007
Wheat - Summer maize (7)	299	81.92	296	81.09	4278.30 [f]	4029.80 [h]
Cotton /wheat in relay intercropping (1)	334	91.50	336	92.05	7397.50 [a]	7719.18 [a]
Wheat – cotton (9)	334	91.50	336	92.05	4138.00 [g]	4043.8 [g]
Fodder maize -wheat – Summer Maize.(3)	352	96.44	350	95.89	4805.47 [d]	5066.70 [d]
Mono-cut clover-wheat- summer maize (4)	352	96.44	350	95.89	6658.65 [b]	6606.80 [b]
Multi-cut clover - Summer maize. (5)	352	96.44	350	95.89	4758.44 [e]	4922.18 [e]
Faba bean - Summer maize (6)	352	96.44	350	95.89	2774.30 [h]	3307.40 [I]
Two cut clover- cotton (8)	388	106.30	387	106.02	5803.00 [c]	5773.00 [c]
Faba bean – Summer maize - fall maize . (2)	418	114.52	415	113.60	4146.10 [g]	4067.40 [f]
F .test					**	**

Example 1:

	Crop sequence (a): relay intercropping . 2005/2006 year		
Wheat: main product : Grain	$Y_{a11=}$ 3.180 Ton/Fed.	$Pr_{a11=}$1100 LE/Ton	$Cost_{a1}$=
by product: Straw	$Y_{a12=}$ 2.775 Ton/Fed	$Pr_{a12=}$500 LE/Ton	1921 LE/Fed
Cotton	$Y_{a21=}$ 8.3 kintar/Fed.	Pr_{a21} =850 LE/kintar	$Cost_{a2}$= 2622 LE/fed
Duration	$D_{a=}$334 days		
Total costs			$Cost_{a1+a2}$=4543LE/Fed
	Crop sequence (b) : crop sequence 8. 2005/2006 year		
Two –cut clover	$Y_{b11=}$ 15 ton/Fed.	$Pr_{b11=}$140 LE/Ton	$Co_{b1=}$900 LE/Fed
Cotton	$Y_{b21=}$ 8.5 kintar/Fed.	Pr_{b21} =850 LE/kintar	Co_{b2} =2622 LE/fed
Duration	D_b=388 days		

m: number of crops pertaining to crop sequence (b). m^{-}: number of main and by products together of crops. Y_{aij}, Pr_{aij} and Co_{aij} :Yield, price and production cost (main and by products)of each crop pertaining to crop sequence (a), respectively.

$Y_{b\,LK}$,Pr_{bLK} and Co_{bLK} : Yield, price and production cost (main and by products) of each crop pertaining to crop sequence (b), respectively.

D_a and D_b : Crop sequence (a) and crop sequence (b) durations by days, respectively. The application of the equation will be applied on one season for example.

The highest net return has been recorded by cotton with wheat in relay intercropping system (Table 4). So, cotton with wheat in relay intercropping system was compared with all sequences under the study by using $EYAR_1$ equation and the net return, and the results obtained were illustrated in Table 5. The given results clearly showed that the sequence 4 of Mono cut clover – wheat – S. maize have a position after relay intercropping cotton with wheat,which relay intercropping cotton with wheat was surpassed the sequence 4 by 17.08 and 11.16 %only of $RYAR_1$ value and Net return ratio, respectively. while the sequence 6 of faba bean – summer maize ranked the last position, which sequence 1 was surpassed the sequence 6 by 181.02 and 166.64 % of $RYAR_1$ value and Net return ratio, respectively. It is may be due to the low both of production and price of faba bean crop. While the sequences that included clover crop were ranked in the forward positions.

Example 1

Economical Yield Advantage Ratio $_{(relay/\ sequ.)}$ ($EYAR_1$) = [((3.18 x 1100 + 2.77x 500 + 8.3x850) – 4543)) 388][(((15x140 -900) + (8.5.0x850 – 2622)))334]$^{-1}$ = 1.4809

Economical Yield Advantage Ratio$_{(\ relay/\ sequ)}$ as percentage = (1.4809 -1) x 100 = + 48.09 %

2-Evaluation of Sequence in comparison with another sequence:

Economical Yield Advantage Ratio $_{(sequ/\ sequ.)}$ ($EYAR_2$):

$$= [(\sum_{i=1}^{n} (\sum_{j=1}^{n^-} Y_{aij}\, Pr_{aij}) - \sum_{i=1}^{n} Co_{ai})\, D_b]$$

$$[(\sum_{L=1}^{m} (\sum_{K=1}^{m^-} (Y_{bLK}\, Pr_{bLK}) - Co_{bL}))\, D_a]^{-1}$$

Economical Yield Advantage Ratio$_{(sequ/\ sequ.)}$ as percentage = (($EYAR_2$) -1)x 100= + %

Formula numerator should be occupied by the wished sequence for evaluation. While the formula denominator should be occupied by the other sequence as a comparing.

Example 2:
Evaluation of sequence 2 by using sequence 6 as a comparing.
Economical Yield Advantage Ratio (Sequence 2 / Sequence 6) ($EYAR_2$)

= [(((1.503 x 1800 +1.530x134-1800) + (4.137x 967 + 3.12x127-1838)+ (2.085x967+3.234x127-1950))) 352][(((1.477x1800 + 1.362 x134 -1841) + (4.02x967+2.913x127 – 2484)))418]$^{-1}$ = 1.2646

Economical Yield Advantage Ratio$_{(sequ\ 2/\ sequ\ 6)}$ as percentage = (1.2646 -1) x 100 = + 26.46 %

In example 2, the intensive sequence 2 of faba bean – summer maize –fall maize was compared with the traditional sequence 6 of faba bean – summer maize. From data obtained in table 4, the duration of intensive sequence 2 recorded area time land occupied of 114.52% (418 days), while the conventional sequence 6 recorded 96.44 % (352 days) area time land occupied. $EYAR_2$ value demonstrated that the intensive sequence 2 was superior to the traditional sequence 6 by 26.46%. While net return ratio as percentage showed 50.18% for the same comparisons (Table 6). The differences between $EYAR_2$ values and net return ratio values due to the variations of area time land occupied of both sequences. So, it can be said that the net return values given were not true enough to evaluate the comparisons between the crop sequences. The intensive sequence 3 of fodder maize – wheat – summer maize was compared with the traditional sequence 7 of wheat – summer maize and showed that $EYAR_2$ values demonstrated that the intensive sequence 3 was failure compared with sequence 7 by -4.59%, this means that the increasing in net return of sequence 3 was not enough for the compensate the increasing in the sequence duration. The same manner was recorded with the sequence 5 comparing by sequence 7 (Table 6).

Regarding economic evaluation of water irrigation amounts of sequences, net return values should be divided by water requirements (m^3)of all crop sequences under the study. Quotient values of relay intercropping registered the highest net return for water square meter (1.357 LE/m^3) as an average of both years compared with the other sequences whether intensive or traditional systems,followed by sequences 8 and 4 which recorded 1.107 and 0.976 LE/m^3 as an average of the two years. The sequence 2 of Faba bean –S.maize – Fall maize (intensive sequence) occupied the last position (0.516 LE/m^3 as an average of both years) and preceded by sequence 6 (0.597 LE/m^3, as an average of the two years), although the water requirements of sequence 6 was equal to 63.9 % of sequence 2 (intensive sequence).

3-Evaluation of a sequence in comparison with relay intercropping system :
Economical Yield Advantage Ratio $_{(sequ/\ relay.)}$ ($EYAR_3$)

$$= [(\sum_{i=1}^{n} (\sum_{j=1}^{n^-} Y_{aij}\ \mathrm{Pr}_{aij}) - \sum_{i=1}^{n} Co_{ai})\ D_b]$$

$$[(\sum_{I=1}^{m} (\sum_{K=1}^{m^-} (Y_{bLK}\ \mathrm{Pr}_{bLK}) - Co_{bL}))\ D_a]^{-1}$$

Economical Yield Advantage Ratio$_{(sequ/\ relay.)}$ as percentage = (($EYAR_3$) -1)x 100= + %

For applying the $EYAR_3$ equation,the sequence that wished to evaluation should be occupied the formula numerator, while the relay intercropping that used as a comparing should be occupied the denominator of formula.

4-Evaluation of relay intercropping in comparing with another relay intercropping system :
Economical Yield Advantage Ratio $_{(relay/\ relay.)}$ (EYAR4)

$$= [(\sum_{i=1}^{n} (\sum_{j=1}^{n^-} Y_{aij}\ \mathrm{Pr}_{aij}) - \sum_{i=1}^{n} Co_{ai})\ D_b]$$

$$[(\sum_{I=1}^{m} (\sum_{K=1}^{m^-} (Y_{bLK}\ \mathrm{Pr}_{bLK}) - Co_{bL}))\ D_a]^{-1}$$

Economical Yield Advantage Ratio $_{(relay/\ relay.)}$ as percentage = (($EYAR_4$) -1)x 100= + %

Concerning $EYAR_4$ equation the relay intercropping that wished to evaluation take up the numerator of formula,while the other relay intercropping wish well be using as a comparative should be occupied the formula denominates.

Conclusion: From results obtained, it can be seen that the EYAR equations can evaluated the intensive and traditional cropping systems based on biological and economics and taken the duration in the consideration and from crop intensification perspective. At the same time as prediction formulas to predict the success of intensive crop sequences from farmers view perspective. So, EYAR equations values given enough true evaluations than the net return values only.

Table 5: Comparisons between relay intercropping of cotton with wheat and various successions systems by using $EYAR_1$ equation (in descending ranks) and net returns (2005-2006 year).

Relay intercropping /Crop sequences systems	$EYAR_1$ values	$EYAR_1$ valuesas %	Net return ratio	Net return ratio
Sequence 1 / sequence 4	1.1708	17.08	1.1116	11.16
Sequence 1 / sequence 8	1.4809	48.09	1.2748	27.48
Sequence 1 / sequence 7	1.5479	54.79	1.7290	72.90
Sequence 1 / sequence 3	1.6224	62.24	1.5393	53.93
Sequence 1 / sequence 5	1.6384	63.84	1.5546	55.46
Sequence 1 / sequence 9	1.7710	77.10	1.7877	78.77
Sequence 1 / sequence 2	2.2330	123.30	1.7842	78.42
Sequence 1 / sequence 6	2.8102	181.02	2.6664	166.64

Table 6: Comparisons between intensive and traditional sequences by using $EYAR_2$ equation and net return (year of 2005/2006).

Crop sequences systems	$EYAR_2$ values	$EYAR_2$as %	Net return ratio	Net return ratio as %
Sequence 2 / Sequence 6	1.26466	26.46	1.50179	50.17
Sequence 3 / Sequence 7	0.95409	- 4.591	1.12321	12.32
Sequence 4 / Sequence 7	1.3220	32.20	1.5563	55.63
Sequence 5 / Sequence 7	0.9447	-5.53	1.1122	11.22

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